Tall Fescue Management – Pasture and Cattle Responses to Endophyte and Fertilization

Investigators

Alan J. Franzluebbers and John A. Stuedemann
USDA – Agricultural Research Service
J. Phil Campbell Sr. Natural Resource Conservation Center
1420 Experiment Station Road, Watkinsville GA 30677-2373
Tel: 706-769-5631 ext 223, Fax: 706-769-8962
Email: afranz@uga.edu
Website: http://www.spcru.ars.usda.gov

Working Hypotheses

1. Toxic effects of wild endophyte association are seasonal and yearlong grazing will dilute negative effects
2. Broiler litter will provide balanced nutrient supply to improve pasture productivity
3. Novel endophyte association will allow better persistence of tall fescue pastures than endophyte-free association
4. Grazing tall fescue pastures will have positive impacts on environmental quality

Objectives

1. Quantify yearling heifer performance and production on a seasonal basis
2. Determine if the effect of endophyte association on cattle performance can be modified by inorganic versus organic fertilization
3. Assess botanical composition in response to endophyte and fertilization
4. Calculate tall fescue productivity under grazed and hayed conditions

Methods

This report describes the first three years of a pasture experiment at the USDA–ARS experiment station in Watkinsville GA. Individual paddocks were 2.5 acre. Seven treatments were replicated two times in a randomized block design:

1. Wild endophyte, inorganic fertilizer, grazed
2. Novel endophyte, inorganic fertilizer, grazed
3. Endophyte-free, inorganic fertilizer, grazed
4. Wild endophyte, broiler litter, grazed
5. Novel endophyte, broiler litter, grazed
6. Endophyte-free, broiler litter, grazed
7. Novel endophyte, inorganic fertilizer, hayed

'Jesup' tall fescue was direct drilled into abandoned cropland in November 2001, following burning of herbicide-killed grasses and forbs that developed during a dozen years after cropping ceased. Roundup and paraquat were used to kill previous vegetation. The three tall fescue seed sources were drilled in 8"-wide rows at a rate of 18-27 lb acre^{-1}. Dolomitic limestone at 1 ton acre^{-1} was spread on all paddocks in March 2002. Good stand of all tall fescue pastures was obtained by spring 2002.

Novel endophyte (Max-Q Jesup distributed by Pennington Seed) produces low levels of ergot alkaloids. Fertilization of pastures occurred each year in early spring and early autumn. Inorganic fertilization was 450-520 lb acre^{-1} of 18-9-18 (N-P_2O_5-K_2O) in spring and 265-280 lb acre^{-1} of 34-0-0 (ammonium nitrate) in autumn. Broiler litter was spread in spring and autumn at 1.1 $\pm$ 0.1 ton acre^{-1} (dry weight) using a truck spreader contracted locally. Yearling Angus heifers grazed pastures until there was 0.4 ton acre^{-1} of available forage, at which time they were removed until sufficient regrowth occurred. In October of each year, new 8-month-old heifers (400 lb head^{-1}) were brought in following deworming with eprinex pour-on and valbazen drench. Paddocks had soil berms adjacent to fences to channel water to a flume to monitor water quality. Soil is being sampled to determine soil quality.

Agricultural Research Service

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JPC Research Note 12

Results

How did pastures respond to fertilization system?

We wanted to supply 25% greater amount of N with broiler litter than with inorganic fertilizer, due to expected incomplete N mineralization and greater volatile loss, but only achieved 12% greater rate in the first 3 years. The supply of P and K with broiler litter was nearly 3 and 2 times greater than with inorganic fertilizer, respectively (Table 1). This difference in nutrient input to pasture systems is expected to have implications on water quality runoff, given equal and large water runoff events.

Table 1. Average quantity of nutrients supplied to tall fescue pastures during 3 years of management at Watkinsville GA.

Fertilization strategy	Nutrients supplied		
	N	P_2O_5	K_2O
	--------- lb acre^{-1} ---------		
Inorganic	160	41	71
Broiler litter	179	116	129

The percentage of ground cover as tall fescue was not different between fertilization strategies initially, but became lower with broiler litter than with inorganic fertilizer in the third year (Table 2). The quantity of forage available to cattle was 0.66 ± 0.20 ton acre^{-1}. Stocking rate varied by season, but was not affected by fertilization strategy (Fig. 1).

Table 2. Botanical composition of pastures in May 2002 (first year) and in July 2004 (third year) under inorganic (IN) and broiler litter (BL) fertilization strategies at Watkinsville GA.

Component	2002		2004	
	IN	BL	IN	BL
	Percent ground cover			
Tall fescue	49	47	79 >	71
Annual grass	26	27	3	7
Broadleaves	0	1	1	2
Bare ground	25	22	17	16

Overall, fertilization strategy did not have very large effects on pasture properties. There were also no significant interactions between fertilization strategy and endophyte association on most pasture responses, suggesting that endophyte effects outlined below were independent of fertilization strategy.

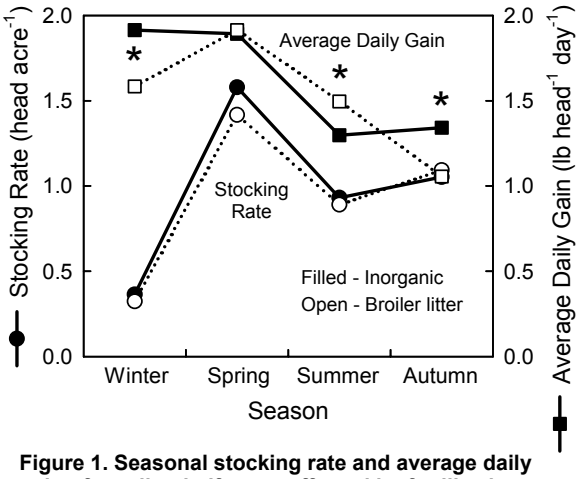

Figure 1. Seasonal stocking rate and average daily gain of yearling heifers as affected by fertilization strategy at Watkinsville GA. * indicates significant difference at p = 0.1.

How did cattle respond to fertilization of pasture?

Average daily gain of cattle was higher with inorganic fertilizer than with broiler litter in winter and autumn, but lower in summer (Fig. 1). Averaged across the year, average daily gain was not different between fertilization strategies (1.56 lb head^{-1} d^{-1}). Stocking of pastures was for 121 days in 2002, for 240 days in 2003, and for 299 days in 2004.

Cumulative live-weight gain was not statistically different between fertilization strategies on a yearly basis, but seasonal differences occurred (Table 3). Cattle gain was lower with broiler litter than with inorganic fertilizer in winter, but higher with broiler litter in summer. High temperature and soil moisture in summer may have allowed significant mineralization of organically bound nutrients in broiler litter to increase forage production and/or quality. Conversely, limited mineralization of organically bound nutrients may have occurred with low temperature in winter. Broiler litter was applied in spring and autumn, but time is needed to make nutrients available to plants.

Table 3. Seasonal and cumulative live-weight gain of yearling heifers averaged across three years as affected by fertilization strategy at Watkinsville GA.

Season	Fertilization Strategy		
	Inorganic		Broiler Litter
	------- lb acre^{-1} -------		
Winter	66	>	49
Spring	262		244
Summer	104	<	122
Autumn	115		96
Yearly total	547		511

How did pastures respond to endophyte association?

Pastures became progressively more dominated by tall fescue with time, rising from ~48% of ground cover in May 2002 to 79% of ground cover in July 2004 with wild and novel endophyte associations, but only to 70% in endophyte-free pastures. Our early results suggest that tall fescue may indeed be persistent with novel endophyte compared with endophyte-free tall fescue. However, more years of research are needed to strengthen this claim.

Pastures were variably stocked with cattle to achieve a similar amount of forage among endophyte associations. However, the average amount of available forage was higher (0.68 ton acre^{-1}) with wild endophyte than with endophyte-free or novel endophyte association (0.62 ton acre^{-1}). Despite the greater amount of forage present, cattle stocking rate was also higher with wild endophyte than with endophyte-free or novel endophyte association (Fig. 2). These results indicate that pastures with novel endophyte performed similarly to endophyte-free pastures. Wild endophyte association allowed greater stocking rate, probably from a combination of reduced forage intake and more vigorous plant growth.

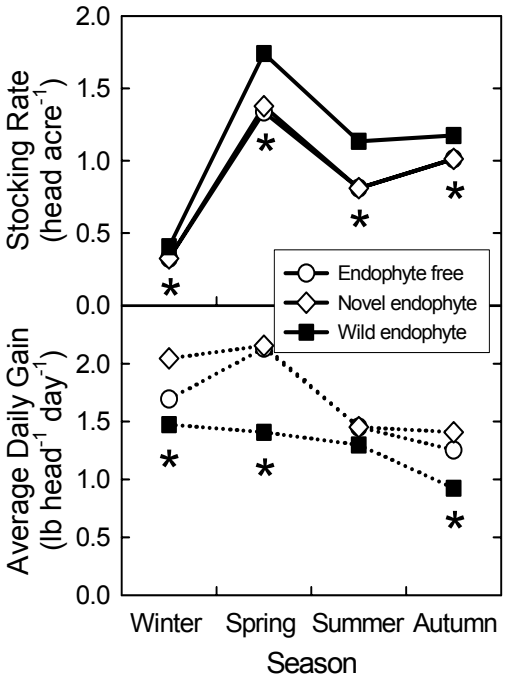

Figure 2. Seasonal stocking rate and average daily gain of yearling heifers as affected by endophyte association during 3 years at Watkinsville GA. * indicates significant difference at p = 0.1.

How did cattle respond to endophyte association?

Average daily gain of cattle was lower with wild endophyte than with endophyte-free or novel endophyte association almost year-round, except in summer when no difference occurred (Fig. 2). Lower performance of cattle on wild endophyte association has been reported often before. The lack of difference in cattle performance during the summer contradicts perceptions that high temperature in summer aggravates fescue toxicosis symptoms. Forage quality of tall fescue in summer simply appears to be low, independent of endophyte association. Performance of cattle was the most affected by wild endophyte in spring, when forage quality appeared to be highest.

Table 4. Seasonal and cumulative live-weight gain of yearling heifers as affected by tall fescue-endophyte association averaged across three years at Watkinsville GA.

Season	Endophyte Association			
	Free	Novel		Wild
	---------- lb acre^{-1} ----------			
Winter	54	62		56
Spring	266	273	>	218
Summer	105	104	<	131
Autumn	113	117		87
Yearly total	538	555		493

Cumulative live-weight gain was not statistically different among endophyte associations when averaged across the three years of this study (Table 4). However, seasonal differences did occur. Live-weight gain was greater with endophyte-free and novel endophyte than with wild endophyte association in spring, but lower than with wild endophyte in summer. Since pastures with wild endophyte were able to support a higher stocking rate, the poorer cattle performance with wild endophyte resulted in only minor differences in total cattle production on these pastures. When cumulative live-weight gain was plotted with time during each of the three years (Fig. 3), a major reduction in cattle production occurred only in 2002 when

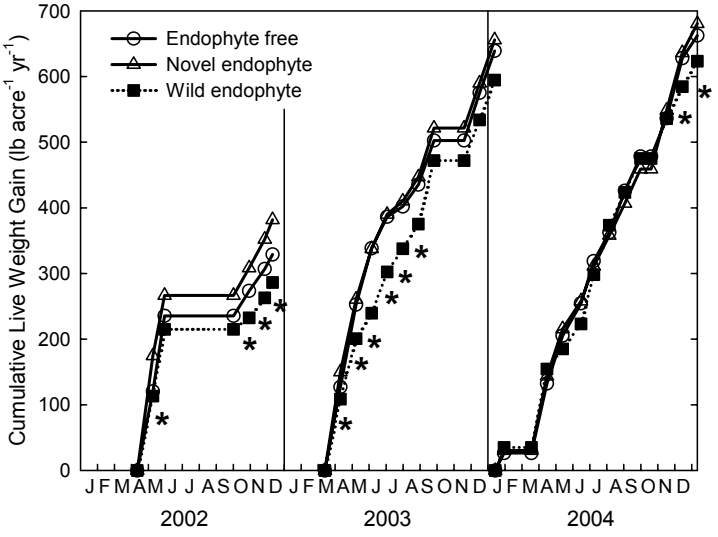

Figure 3. Cumulative live-weight gain of yearling heifers as affected by tall fescue-endophyte association during three years at Watkinsville GA. * indicates significance among means at p = 0.1.

gain was lowest, because of drought and newly established grass stand that limited stocking. Differences in production that occurred in the spring of 2003 were removed by the end of the year, because of compensation later in the year. In 2004, minor differences in cattle production occurred only very late in the year. Our results suggest that beef cattle producers might be able to find several management opportunities (e.g., fertilization strategy, timing and intensity of stocking, as well as others) to overcome the negative consequences of wild endophyte association on cattle performance and production.

What was grass production with haying compared to grazing?

The quantity of hay produced by inorganically fertilized tall fescue with novel endophyte association was highly dependent upon precipitation among years (Table 5). Potential cattle gain assuming hay were fed to animals similar in condition to those grazing pastures would have been 256 lb acre^{-1} in 2002, 445 lb acre^{-1} in 2003, and 403 lb acre^{-1} in 2004. Therefore, grazing resulted in greater cattle gain (593 $\pm$ 182 lb acre^{-1}) than would have occurred with haying (368 $\pm$ 99 lb acre^{-1}).

Table 5. Hay yield from inorganically fertilized tall fescue with novel endophyte association at Watkinsville GA.

Period	2002	2003	2004
	---------- ton acre^{-1} ----------		
Spring	1.3	0.5	0.6
Summer	–	1.8	0.9
Autumn	–	–	0.5
Yearly total	1.3	2.2	2.0

Harvests were on 31 MAY 2002, 17 APR 2003, 5 SEP 2003, 28 APR 2004, 10 JUL 2004, and 19 OCT 2004.

Summary and Implications

- Yearling heifers grazing tall fescue pastures had greatest performance in winter and spring on endophyte-free and novel endophyte associations, because of high forage quality and lack of ergot alkaloids produced by a common “wild” tall fescue-endophyte association.
- Pasture and cattle responses were only slightly affected whether fertilization was from inorganic or broiler litter sources. However, timing of nutrient availability could affect quality of forage, thereby affecting cattle performance. Long-term research will be needed to validate these results.
- Persistence of tall fescue with novel endophyte was as good as with wild endophyte and greater than with endophyte-free pastures, at least during the first three years. More years of research are needed to better assess persistence of novel endophyte associations.
- Cattle performance on tall fescue with novel endophyte association was similar to that on endophyte-free pastures, both of which were greater than on wild endophyte association. However, cattle production per land area was not different among endophyte associations, because pastures with wild endophyte had a higher stocking rate than endophyte-free or novel endophyte associations.
- The smaller performance gaps of cattle grazing pastures with wild endophyte compared with endophyte-free association in winter and summer suggest that close grazing in winter and early spring with pasture deferment later in spring and restocking of pastures again in summer might be a possible avoidance strategy to get better overall performance of beef cattle on tall fescue pastures with wild endophyte association. More research is needed to better understand how tall fescue pastures with wild endophyte might be managed to avoid fescue toxicosis.
- This experiment has been designed for long-term research to better understand how pasture management and tall fescue-endophyte associations might affect soil and water quality on a landscape level.

For a full description of this research, see:

Franzluebbers AJ, Stuedemann JA. 2006. Pasture and cattle responses to fertilization and endophyte association in the southern Piedmont, USA. *Agriculture, Ecosystems and Environment*, vol. 114, p. 217-225.

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